

Wind Energy Program

TECHNOLOGY OVERVIEW

Wind turbines capture the kinetic energy in the wind, converting it into electrical energy. The turbines have rotors that typically consist of two or three propeller-like blades mounted on a shaft. Utility-scale turbines are mounted on tall towers, usually 100 feet or more above the ground where the wind is faster and less turbulent.

When wind makes the blades turn, the rotational energy in the shaft can be used to operate a mechanical device, such as a water pump, or can be used by a generator to produce electricity. In utility-scale power applications, anywhere from one or two to several hundred turbines are connected to the utility grid, providing electricity when the wind blows.

The wind blows because of differences in atmospheric pressure created by geography and the temperature differences across the Earth's surface; these temperature variations are caused by variations in the amount of sunshine falling on different areas – for this reason, wind is considered an indirect form of solar energy.

U.S. DEPARTMENT OF ENERGY PROGRAM

The mission of the U.S. Department of Energy (DOE) Wind Energy Program is to enable the U.S. wind energy industry to complete the research, testing, and field verification needed to fully develop advanced wind energy technologies that will lead the world in cost-effectiveness and reliability. Partnering with industry is an important part of the program and has contributed to an 85% reduction in the cost of energy from wind over the past 20 years.

The research to support the program is carried out at two national laboratories: the National Renewable Energy Laboratory (NREL) in Golden, Colorado, and Sandia National Laboratories in Albuquerque, New Mexico. NREL is home to the National Wind Technology Center, a world-class research facility where engineers conduct laboratory and field tests to support the U.S. wind energy industry.

The Wind Energy Program has three major components:

- **Turbine research** – Features government-industry partnerships to develop, test, and refine advanced turbine designs using the latest design codes and engineering analyses.

- **Applied research** – Addresses fundamental engineering principles and technology issues that must be understood in order to improve wind turbines.

- **Cooperative research** – Encourages widespread use of wind energy through collaborations with the wind energy industry, end users such as utilities and government, and international agencies and laboratories.

Warren Gretz, NREL/PIX00349



This test machine at DOE's National Wind Technology Center is used to measure wind pressure distributions. R&D jointly sponsored by the Wind Energy Program and U.S. industry has dramatically lowered the cost of electricity from wind, to the point where wind power is beginning to compete with conventional generation.

WIND ENERGY PROGRAM

A New Crop for America's Heartland

Wind offers a new crop for America's Heartland and its landowners, farmers, ranchers, and tribal lands. Throughout the Midwest and Upper Great Plains, many farmers and ranchers are suffering from low prices for their crops.

In Lake Benton, Minnesota, a family that has been farming the same land since 1884 was barely making a living and looking to sell their homestead. Instead, wind power is being developed on their property, providing over \$40,000 in revenue. This "windfall" has allowed them to do two things for the first time in generations – become debt-free and put away savings for retirement.

This story is being repeated in small communities from Maine to California, Minnesota to Texas, and many others in between – allowing private investment, purchases of new homes, payments for college tuition, and public infrastructure investment. Even public schools have benefitted, such as the \$400,000 in revenue that has gone to the Texas Permanent School Fund from a wind project in West Texas.



Warren Grez, NREL/PIX06331

In rural America, wind turbines can easily coexist with farming and ranching.

MARKET POTENTIAL

Throughout the 1990s, wind energy has been the fastest-growing energy technology worldwide, achieving an annual growth rate of over 30%. In 1999, worldwide installed wind capacity surpassed 10,000 megawatts (MW). While much of the new capacity was added in Europe, where electricity from conventional sources is more expensive, the U.S. market is gaining strength.

The European Wind Energy Association estimates that more than 30,000 MW of new wind capacity will be installed in Europe in the next ten years. The American Wind Energy Association estimates U.S. installed capacity will break the 5000 MW level by the end of 2001 – representing over \$5 billion in new investments throughout the United States. The DOE Wind Energy Program supports U.S. manufacturers of utility-scale and small wind turbines in their efforts to penetrate international markets by helping them meet international certification requirements.

In the United States, more than 1000 MW of new wind projects were installed in 1999, bringing total U.S. installed capacity to approximately 2500 MW. Wind energy project development in the Great Plains and the Midwest was particularly strong, tapping into the large wind resource there. Factors contributing to this boom include state legislative requirements for greater use of wind power (in Iowa and Minnesota), the falling cost of wind energy, and the benefits of wind energy in competitive utility markets.

Wind energy is a clean, renewable technology that is preferred by some utility customers. And thanks to the DOE/NREL Utility Turbine Verification Program, utilities have had positive experiences operating wind turbines and gaining experience with this technology. As concerns about global climate change grow, wind energy is likely to take a more prominent place among generation technologies.

Markets for off-grid systems are also strong. It is estimated that more than two billion people around the world live without electricity. Small wind turbines, coupled with other technologies – such as diesel generators, photovoltaics, and batteries (collectively called hybrid systems) – can provide power for remote villages.

For More Information:

DOE Wind Energy Program
Web: <http://www.eren.doe.gov/wind/>

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